Third United Nations International Conference on the Peaceful Uses of Atomic Energy

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Abstract

EIGENFUNCTION EXPANSION METHOD IN NEUTRON TRANSPORT THEORY

R. Żelazny
Institute of Nuclear Research, Warsaw

The paper is devoted to the general solution of the Boltzmann equation of neutron transport theory by means of the eigenfunction expansion method, which opens new and wide perspectives in this field.

The method is described on the basis of the one-velocity Boltzmann equation with isotropic scattering of neutrons for arbitrary geometry.

The fundamental notion of the eigenfunction and the eigenvalue of this equation is introduced and their properties are discussed. Then the general solution of the Boltzmann equation is constructed and the boundary value problem formulated.

Some examples of problems with different symmetry properties are given. Other efforts in this direction based on different ways of attack are reviewed critically and commented. This relates specially to spherically symmetric problems.

This approach is extended later taking into account the anisotropic scattering of neutrons, energy dependent kernels and time-dependent problems in plane geometry. The eigenvalues and corresponding eigenfunctions for these cases are discussed and the appropriate completeness theorems are sketched. The possible applications of this approach to critical and spectral problems in reactor theory are formulated and examined.

In the Appendix the most important information concerning the theory of singular integral equations and basic mathematical concepts relevant from the point of view of their application in neutron transport theory is given and discussed.

Special attention is paid to the problem of reduction of the singular integral equations to the Fredholm ones, and to the additional conditions which must be satisfied by their solutions. These conditions are connected intimately with the indices of singular integral equations and play the most important, physical role in the theory.

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Abstract

MICROSCOPIC NEUTRON FLUX DISTRIBUTION IN ELEMENTARY CELLS OF CRITICAL ASSEMBLIES OF NPY - PROJECT

Collective work

from

Institute of Nuclear Research, Świerk, Poland
IFA, Kjeller, Norway
and Institute "Boris Kidrič", Vinca, Yugoslavia

There exist three critical assemblies in Norway, Poland and Yugoslavia.

According to the NPY Cooperative Program a series of neutron flux distribution measurements and calculations has been done for each of these assemblies.

This paper discusses the measurements done on 3% enriched uranium rods in the D_2O moderated Norwegian "NORA" reactor, on 20% enriched 3-concentric tubular fuel elements in the graphite water moderated Polish reactor "ANNA" and on 2% enriched tubular type fuel elements in the D_2O moderated Yugoslavian RB reactor.

Experimental results are analyzed using 3 independent reactor cell calculation methods, "K.7 - Thermos" code devoloped at IFA, Kjeller and analytical thermalization methods developed in Poland and Yugoslavia.

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Abstract

RECENT DEVELOPMENTS IN CONTROL AND SAFETY SYSTEMS FOR NUCLEAR REACTORS AT THE INSTITUTE OF NUCLEAR RESEARCH IN POLAND

J.Podgórski, P.Szulc
Institute of Nuclear Research, Świerk, Poland

In this paper there are discussed the control and safety systems of the ANNA critical assembly and the MARYLA low-power, swimming-pool type reactor, both put into operation at the ŚWIERK Centre in 1963, as well as further developments in the control systems for nuclear reactors being designed at present in Poland.

The ANNA critical assembly as a nuclear model of the high - flux research reactor of /20-30 MW/ has been equipped with a control system more ample than that which would be required usually for a critical assembly, in order to accumulate experience on its operation. This system consists of the following main measuring channels:

1/ Pulse start - up channel /two-lines/ controlling the reactor period in a 5-decade power range.
2/ Current logarithmic channel /two identical lines/ controlling the reactor period in a 5-decade power range.
3/ Current linear channel /three identical lines in "2 out of 3" system/ controlling the power-level in a two-decade range.
4/ Automatic power-level regulation channel.

The electronic equipment in that system contains special reliability-controlling circuits. In the linear channel a special comparative circuit with constant relative sensitivity independent from power-level has been developed.

The control and safety system of the MARYLA reactor consists of the following

channels:

1/ Current logarithmic channel, with two identical lines which controls the reactor period in about 7 decades /1 mW - several kW/ power range.

2/ Current linear multi-range channel, operating in a controlled "2 out of 3" system, covering a power-range from 50 mW up to 1 kW.

3/ II step safety channel in controlled "2 out of 3" system with adjustable trip-levels in a power range of hundreds W up to several kW, with G.M. current counters as "gamma power" detectors.

Logarithmic and linear channels serve to measure and secure the reactor period and power-level. The II step safety channel plays a role of additional "fuse". Its action shuts down the reactor by ejection of a fuel element section. The transistorized pulse start-up channel and automatic power-level regulation channel are in their design stage.

The paper desoribes both control systems and the related electronic equipment, detectors and control-rod drive mechanisms.

At present, two new control and safety systems for 5 MW and 30 MW research reactors are being developed. The new system /a modified controlled "2 out of 3" system/ of high structural reliability is being tested. The multipoint control high-speed-switch equipment for temperature and flow-rate measurements is in the design stage.

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Abstract

PROSPECTING AND MINING OF NUCLEAR RAW MATERIALS IN PORTUGAL

Rogério Cavaca,

Director General, Prospecting and Mining Services,

Junta de Energia Nuclear, Lisbon

A uraniferous deposit was first discovered in metropolitan Portugal in 1909. This was followed by intensive prospecting and mining, having exclusively in view the production of radium, subject to the varying conditions of production costs, supply and demand.

From 1910 to 1944 a total of ca. 25,000 tons of high grade ore (0.50 % to 1.00 % of U_3O_8) were mined. The production of radium from this ore amounted to about 50 grams.

Mining for the production of uranium started with the advent of the atomic era. 1325 tons of U_3O_8 were produced from 1950 to 1962.

A program of systematic radiometric prospecting was started in 1955 covering a favourable geological facies, namely all hercynic granitic massifs, all adjacent pre-ordovician schist complexes, and the continental formations belonging to the Autunian and the Miocene-Pliocene.

Numerous occurrences and uraniferous deposits of various metallogenic types were identified. Predominant among these were veined ore deposits with more or less complex gangues - these being until then the only deposits which were known and had been exploited - and bearing surface impregnations of secondary metals on the metamorphic aureoles of some granitic massifs. These deposits showed favourable prospects.

This was followed, starting in 1959, by the systematic exploration of the more important deposits by means of borings and underground work. This is expected to continue through 1965.

It will not be possible to determine the uranium reserves with a certain degree of precision before the conclusion of this work. On the basis of present knowledge a preliminary estimate of reserves in metropolitan Portugal may be placed at 6,000 tons of U_3O_8, in ores of an average grade of 0.20 %.

Air-borne radiometric and magnetic surveying was carried out in Mozambique during 1961 and 1962, covering four areas selected according to their geological and structural characteristics. These comprises Basement Series, igneous rocks, Karoo System and carbonatites, totalling 24,000 sq. km.

A great number of anomalies, having in general small amplitudes, has been recorded, which may be attributable to complex uranium and thorium ores, the latter being the predominant mineral. The systematic study of these anomalies will be initiated soon.

The well-known Tete deposits, located in the vicinity of one of those areas, contain refractory mineralisation (davidite and samarskite) found in 1947. Total production from 1949 through 1957 amounted to 388 tons. Determination of reserves is at present being worked on.

The pegmatitic areas in the Zambézia district have been surveyed in 1963, with a view to coordinating all geological, metallogenic and economic data concerning the important deposits that have been discovered since 1940. Its mineralisation is rich and diversified. Beryl and columbite - tantalites are the predominant minerals. Production from 1956 through 1963 amounted to 7,822 and 985 tons, respectively. Estimates of the order of magnitude of the reserves are being prepared.